



## COVER SHEET

### Access 5 Project Deliverable

**Deliverable Number:** CM003

**Title:** *Mission Planning Requirements Document, Preliminary Version*

**Filename:** CM003\_Mission Planning Requirements\_RevA\_FINAL.doc

**Abstract:**

*The purpose of this document is to identify the general flight/mission planning requirements for same-day file-and-fly access to the NAS for both civil and military High-Altitude Long Endurance (HALE) Unmanned Aircraft System (UAS). Currently the scope of this document is limited to Step 1, operations above flight level 43,000 feet (FL430).*

*This document describes the current applicable mission planning requirements and procedures for both manned and unmanned aircraft and addresses HALE UAS flight planning considerations in the future National Airspace System (NAS). It also discusses the unique performance and operational capabilities of HALE UAS associated with the Access 5 Project, presents some of the projected performance characteristics and conceptual missions for future systems, and provides detailed analysis of the recommended mission planning elements for operating HALE UAS in the NAS.*

**Status:**

|  |
|--|
| <b>WP – Work in Progress<br/>Draft</b> |
|  |

**Limitations on use:**

*This document is a first draft reviewed by the Contingency Management work package team, the Technology IPT lead, and the SEIT. It is a work in progress that has not been validated by simulation or flight test activities to date. It is also limited in scope to the enroute portions of flight in the NAS above FL430. Additional work is required to complete both the high level functional requirements below FL430 and the more detailed performance guidelines at all levels of flight.*

# **WORK PACKAGE 5 CONTINGENCY MANAGEMENT**

## **MISSION PLANNING REQUIREMENTS DOCUMENT**

**Preliminary Version**

**28 February 2005**

**(Revision A - 31 March 05)**

Prepared by:



**NASA ACCESS 5  
Work Package 5, Mission Planning Team**

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

[illegible]

## Signature Page

---

|  |      |
|--|------|
| Dave Buis                                | Date |
| Systems Engineering and Integration Lead |      |

---

|                 |      |
|-----------------|------|
| Jim Evans       | Date |
| Technology Lead |      |

---

|  |      |
|--|------|
| Bernie Schmidt                           | Date |
| Contingency Management Work Package Lead |      |

---

|                                   |      |
|-----------------------------------|------|
| Eddie Norris                      | Date |
| CM Mission Planning Activity Lead |      |

# Table of Contents

|   |           |
|---|-----------|
| <b>EXECUTIVE SUMMARY .....</b>  | <b>1</b>  |
| <b>1.0 INTRODUCTION .....</b>   | <b>2</b>  |
| 1.1 PURPOSE .....   | 2         |
| 1.2 BACKGROUND .....  | 2         |
| 1.3 SCOPE .....   | 2         |
| <b>2.0 BACKGROUND ON FLIGHT/MISSION PLANNING.....</b>                           | <b>3</b>  |
| 2.1 FLIGHT PLANNING FOR MANNED AIRCRAFT IN THE NAS .....                        | 3         |
| 2.2 CURRENT UNMANNED FLIGHT PLANNING PROCESSES .....                            | 5         |
| 2.3 HALE UAS FLIGHT PLANNING CONSIDERATIONS IN THE FUTURE NAS .....             | 6         |
| 2.3.1 <i>High Altitude Redesign</i> .....                                       | 6         |
| 2.3.2 <i>Domestic Reduced Vertical Separation Minima</i> .....                  | 6         |
| 2.3.3 <i>Privatization of the Automated Flight Service Station System</i> ..... | 6         |
| 2.3.4 <i>Digital Communication in the Future for ATC</i> .....                  | 6         |
| 2.3.5 <i>Proposed Operational Improvements to the NAS</i> .....                 | 7         |
| <b>3.0 HALE UAS UNIQUE PERFORMANCE AND OPERATIONS.....</b>                      | <b>8</b>  |
| 3.1 CURRENT HALE UAS DESCRIPTIONS .....   | 8         |
| 3.1.1 <i>Helios</i> .....   | 8         |
| 3.1.2 <i>Perseus B</i> .....  | 8         |
| 3.1.3 <i>Altair</i> .....   | 8         |
| 3.1.4 <i>Global Hawk</i> .....  | 8         |
| 3.2 PROJECTED PERFORMANCE CHARACTERISTICS .....                                 | 9         |
| 3.3 PROJECTED HALE UAS MISSIONS AND SCENARIOS.....                              | 9         |
| 3.3.1 <i>Security Surveillance</i> .....  | 10        |
| 3.3.2 <i>Surveying and Agricultural/Atmospheric Monitoring</i> .....            | 10        |
| 3.3.3 <i>Communications Relay</i> .....   | 10        |
| <b>4.0 HALE UAS FLIGHT/MISSION PLANNING IN THE NAS.....</b>                     | <b>11</b> |
| 4.1 FLIGHT PLAN DOCUMENTATION AND PROCESSING .....                              | 11        |
| 4.1.1 <i>Current Flight Plan Considerations for HALE UAS</i> .....              | 11        |
| 4.2 WEATHER .....   | 14        |
| 4.3 COMMUNICATIONS .....  | 15        |
| 4.3.1 <i>General</i> .....  | 15        |
| 4.3.2 <i>Communications between the Pilot and the Aircraft</i> .....            | 15        |
| 4.3.3 <i>Communications between the Pilot and Air Traffic Control</i> .....     | 16        |
| 4.3.4 <i>Communications between Air Traffic Control and the Aircraft</i> .....  | 17        |
| 4.4 AIRFIELD OPERATIONS .....   | 17        |
| 4.5 AIRSPACE.....   | 17        |
| 4.6 TRAFFIC AVOIDANCE .....   | 18        |
| 4.7 ALTERNATE/EMERGENCY AIRFIELD .....  | 18        |
| 4.8 CONTROL ELEMENT.....  | 19        |
| 4.9 CONTINGENCY PLANNING.....   | 19        |
| 4.9.1 <i>Lost Link</i> .....  | 19        |

|             |   |           |
|-------------|---|-----------|
| 4.9.2       | <i>Lost Communications</i> .....  | 20        |
| 4.9.3       | <i>Onboard System Failures</i> .....  | 20        |
| 4.9.4       | <i>Control Station Abnormalities</i> .....  | 20        |
| 4.9.5       | <i>Abnormal/Emergency Termination of Flight</i> .....                                   | 20        |
| 4.9.6       | <i>Weather Issues</i> .....   | 20        |
| 4.9.7       | <i>Multiple Failures</i> .....  | 20        |
| <b>5.0</b>  | <b>SUMMARY OF PLANNING RECOMMENDATIONS</b> .....  | <b>21</b> |
| 5.1         | HALE UAS MISSION PLANNING REQUIREMENTS .....  | 21        |
| 5.2         | HALE UAS MISSION PLANNING REQUIREMENT TRACEABILITY.....                                 | 23        |
| <b>6.0</b>  | <b>ACRONYMS</b> .....   | <b>25</b> |
| <b>7.0</b>  | <b>DEFINITIONS</b> .....  | <b>26</b> |
| <b>8.0</b>  | <b>BIBLIOGRAPHY</b> .....   | <b>27</b> |
| <b>9.0</b>  | <b>APPENDIX A: FAA ORDER 7610.4K, CHAPTER 12, SECTION 9</b> .....                       | <b>1</b>  |
| 9.1         | 12-9-1. OPERATION .....   | 1         |
| 9.2         | 12-9-2. PROCEDURES.....   | 1         |
| <b>10.0</b> | <b>APPENDIX B: FUNCTIONAL REQUIREMENTS FOR A HALE ROA MISSION PLANNING SYSTEM</b> ..... | <b>4</b>  |

# **EXECUTIVE SUMMARY**

The Access 5 Project seeks to make unmanned flight in the National Airspace System (NAS) as routine as manned aircraft flight. To make this vision a reality there are several hurdles to overcome in the areas of technology, procedures, and policy. The Access 5 partners have organized to explore the requirements in each of these areas; one focus is in the area of flight/mission planning. There are some significant differences from manned aircraft that will require current flight planning requirements and procedures to be modified or supplemented in order to make routine unmanned aircraft operations a reality.

Section 1.0 explains that the purpose of this document is to identify the general flight/mission planning requirements for same-day file-and-fly access to the NAS for both civil and military High-Altitude Long Endurance (HALE) Unmanned Aircraft System (UAS). Section 1.0 also describes the background of ACCESS 5 and establishes that in Step 1, the scope of the mission planning activity for HALE UAS is for operations above flight level 43,000 feet (FL430).

Section 2.0 describes the current applicable mission planning requirements and procedures for both manned and unmanned aircraft. Additionally, Section 2.3 addresses HALE UAS flight planning considerations in the future National Airspace System (NAS).

Section 3.0 discusses the unique performance and operational capabilities of HALE UAS associated with the Access 5 Project, and presents some of the projected performance characteristics and conceptual missions for future systems.

Section 4.0 provides detailed analysis of the mission planning elements for operating HALE UAS in the NAS.

Section 5.0 summarizes the mission planning recommendations with traceability to the ACCESS 5 Concept of Operations and the ACCESS 5 Functional Requirements Document.

The remaining sections and appendices provide list of acronyms, definitions, and supporting information and references used to generate this document.

## **1.0 INTRODUCTION**

### **1.1 Purpose**

The purpose of this paper is to identify general flight/mission planning requirements for same-day file-and-fly access to the NAS for both civil and military High-Altitude Long Endurance (HALE) Unmanned Aircraft System (UAS). Additionally, this document identifies current flight planning procedures, policies, and infrastructure as well as planned NAS operational improvements that need development/modification to ensure safe and efficient operations given the unique HALE UAS performance capabilities and missions.

### **1.2 Background**

Access 5 is a National Aeronautics and Space Administration (NASA) sponsored project that seeks to enable routine operation of HALE UAS in the NAS, and create the environment for a robust civil and commercial UAS market. Currently, unmanned aircraft receive authorization for flight in the NAS through the issuance of a Certificate of Authorization (CoA) under FAA Order 7610.4K, Special Military Operations, Ch. 12, Sect. 9; however, the application for a CoA is required to be filed at least 60 days prior to flight for all operations outside of Restricted Areas and Warning Areas.

Under the Access 5 project, NASA is participating with the Federal Aviation Administration (FAA), Department of Defense (DoD), and industry, to assist in the development of standards, regulations, and procedures, demonstrate technologies, and identify infrastructure requirements designed to allow routine operation of unmanned aircraft in the NAS with the ability to file and fly the same day. Since the flight plan is how a pilot's intentions are conveyed to Air Traffic Control (ATC), effective flight/mission planning is essential to the achievement of same day approval for unmanned flight operations, as envisioned by the Access 5 project.

### **1.3 Scope**

This document version is being developed for Step 1 of the Access 5 project and therefore is focused on mission/flight planning requirements and issues that exist for unmanned operations above 43,000 feet (FL430) with take-offs and landings in pre-coordinated/restricted airspace. As the Access 5 project progresses this document will be refined and updated to ultimately include mission/flight planning requirements for unmanned operations above 18,000 feet (FL180) with take-offs and landings at UAS designated airports including emergency landings.

Since HALE UAS may differ significantly in their complexity and operational capability, thus requiring different levels of effort in mission/flight planning, this document only attempts to identify general requirements that apply to all HALE UAS.



## **2.0 BACKGROUND ON FLIGHT/MISSION PLANNING**

In developing flight/mission planning requirements for HALE UAS a review of current requirements and procedures for both manned and unmanned aircraft was accomplished and is documented in this section. Additionally, a review of proposed upgrades in NAS systems and procedures that will impact flight/mission planning was conducted to ensure the requirements put forth in this document are in accord with future NAS developments.

While flight planning is a well known term to all aviators, mission planning is a term that may not be quite so well known in the civil aviation community. For the purposes of this document, flight planning will be considered a subset of the mission planning process. The mission planning process is focused on achievement of mission objectives and will result in a detailed route of flight and other data necessary to achieve these specific mission objectives. Planning considerations related solely to the operation of onboard mission equipment is not considered part of flight planning, and should not be required to be put in the flight plan which is to be submitted to the FAA.

### **2.1 Flight Planning for Manned Aircraft in the NAS**

For Instrument Flight Rules (IFR) flights away from the departure airport, Federal Aviation Regulation (FAR) 91.103 requires a pilot-in-command, before beginning a flight, to become familiar with all available information including weather, fuel requirements, alternate airports, traffic delays, performance data, and airport information. The general guidance is that pilots should use all available sources to gather and assess the data that will enable them to conduct a safe flight.

In the information age pilots have a number of methods to gather the required information aside from contacting a FAA Flight Service Station (FSS) or Automated Flight Service Stations (AFSS) where a specialist will provide preflight information. For example, pilots may use the FAA's Direct User Access Terminal System (DUATS) which provides an official weather briefing, and flight planning information via the internet.

Once a pilot has checked the required information for their flight from an official source, the next step is to file a flight plan. The information required for an IFR flight plan is found in FAR 91.169 and falls into the following general categories:

1. Aircraft or flight ID
2. Pilot information, including name, address, telephone number, and a point of contact at destination. (some of this information is optional)
3. Aircraft type with a suffix indicating avionics equipage
4. Departure point and arrival point
5. Flight path information, including route\* and altitude
6. Timing information, including departure time and enroute time
7. Contingency information, including fuel on board (in hours/mins), alternate airports, number of persons onboard, and color of aircraft.

For a domestic IFR flight, this information is filed on a standard FAA Form 7233-1 (Figure 1). Other forms are available for international flights or flights that will penetrate an Air Defense Identification Zone (ADIZ). The information can be filed electronically through various internet websites or by phone with an FAA Flight Service Station. The flight plan must be filed at least 30 minutes before the planned departure time. The filing of a requested route and departure time in the IFR flight plan is not a guarantee that the flight will be cleared accordingly, depending on weather, traffic delays and other factors.

| U.S. DEPARTMENT OF TRANSPORTATION<br>FEDERAL AVIATION ADMINISTRATION                                     |  |                            |  | (FAA USE ONLY) <input type="checkbox"/> PILOT BRIEFING <input type="checkbox"/> VNR   |  | TIME STARTED  |  | SPECIALIST INITIALS |  |   |  |                      |  |
|--|--|----------------------------|--|---|--|---|--|---------------------|--|---|--|----------------------|--|
| FLIGHT PLAN  |  |                            |  | <input type="checkbox"/> STOPOVER   |  |   |  |                     |  |   |  |                      |  |
| 1. TYPE<br><input type="checkbox"/> VFR<br><input type="checkbox"/> IFR<br><input type="checkbox"/> DVFR |  | 2. AIRCRAFT IDENTIFICATION |  | 3. AIRCRAFT TYPE / SPECIAL EQUIPMENT  |  | 4. TRUE AIRSPEED<br><br>KTS                                       |  | 5. DEPARTURE POINT  |  | 6. DEPARTURE TIME<br>PROPOSED (Z)      ACTUAL (Z) |  | 7. CRUISING ALTITUDE |  |
| 8. ROUTE OF FLIGHT   |  |                            |  |   |  |   |  |                     |  |   |  |                      |  |
| 9. DESTINATION (Name of airport and city)  |  |                            |  | 10. EST. TIME ENROUTE<br>HOURS      MINUTES   |  | 11. REMARKS   |  |                     |  |   |  |                      |  |
| 12. FUEL ON BOARD<br>HOURS      MINUTES  |  | 13. ALTERNATE AIRPORT(S)   |  |   |  | 14. PILOT'S NAME, ADDRESS & TELEPHONE NUMBER & AIRCRAFT HOME BASE |  |                     |  |   |  | 15. NUMBER ABOARD    |  |
| 17. DESTINATION CONTACT/TELEPHONE (OPTIONAL)   |  |                            |  |   |  |   |  |                     |  |   |  |                      |  |
| 16. COLOR OF AIRCRAFT  |  |                            |  | CIVIL AIRCRAFT PILOTS: FAR Part 91 requires you file an IFR flight plan to operate under instrument flight rules in controlled airspace. Failure to file could result in a civil penalty not to exceed \$1,000 for each violation (Section 901 of the Federal Aviation Act of 1958, as amended). Filing of a VFR flight plan is recommended as a good operating practice. See also Part 99 for requirements concerning DVFR flight plans. |  |   |  |                     |  |   |  |                      |  |

FAA Form 7233-1 (8-82)  
Electronic Version (Adobe)
CLOSE VFR FLIGHT PLAN WITH \_\_\_\_\_ FSS ON ARRIVAL

  

| MILITARY STOPOVER (FAA USE ONLY)                                     |         |                         |          |                                 |             |         |          |
|--|---------|-------------------------|----------|---------------------------------|-------------|---------|----------|
| TYPE<br><input type="checkbox"/> IFR<br><input type="checkbox"/> VFR |         | AIRCRAFT IDENTIFICATION |          | AIRCRAFT TYPE/SPECIAL EQUIPMENT |             | REMARKS |          |
| DEPARTURE POINT  |         | DESTINATION             |          | ETA                             |             |         |          |
| TAS  | DEP. PT | ETD                     | ALTITUDE | ROUTE OF FLIGHT                 | DESTINATION | ETE     | REMARKS  |
| KTS  |         |                         |          |                                 |             |         |          |
| KTS  |         |                         |          |                                 |             |         |          |
| KTS  |         |                         |          |                                 |             |         |          |
| KTS  |         |                         |          |                                 |             |         |          |
| REMARKS  |         |                         |          |                                 |             |         | INITIALS |

FAA Form 7233-1 (8-82)  
Electronic Version (Adobe)

Figure 1 – FAA Form 7233-1

These requirements from FAR Part 91 apply to all aircraft and all operators. In addition to these requirements, if unmanned aircraft are operated under other Parts of the FARs there may be additional flight/mission planning considerations. For example, FAR Part 121 that covers Domestic, Flag, and Supplemental Operations (i.e., “air carriers”) includes paragraph 121.535 which specifies that “the pilot in command and the aircraft dispatcher are jointly responsible for the preflight planning, delay, and dispatch release of a flight in compliance with this chapter and operations specifications”. Persons operating charters, commuters, IFR helicopter operations, and military aircraft have similar requirements specific to each type of operation.

Once a pilot or dispatcher completes the flight plan, it is sent to the flight data processing computer at the Air Route Traffic Control Center (ARTCC) with responsibility for the departure airport. The information can be sent via a FSS computer or a pilot may file directly from an internet website. Federal Aviation Order 7110.10, Flight Services (Ref. 2), prescribes procedures and phraseology for use by air traffic personnel providing flight services; chapter 6 of this document provides information on the processing of flight plans.

The information from the flight plan is received at the ARTCC and checked for validity and whether any preferred departure routes (PDRs), preferred arrival routes (PARs), or preferred IFR routes apply to that particular aircraft. PDRs and PARs are determined by a letter of agreement or through facility directives. If this particular flight will be affected one of these types of routes, the preferred route will be printed on the flight progress strip.

If the route information entered is incorrect or incomplete, an error message is returned. It then becomes the responsibility of the person who filed the flight plan to correct the entry, ensuring that the route information is complete. At this point the abbreviation FRC (Full Route Clearance) is appended to the corrected flight data and then retransmitted to the ARTCC. If FRC is indicated on the flight plan, the pilot is read the full route clearance prior to flight instead of the normal “abbreviated” clearance. The abbreviation FRC is also printed on the aircraft's flight progress strip, which alerts subsequent controllers that changes were made to the pilot's route of flight.

## **2.2 Current Unmanned Flight Planning Processes**

Unmanned Aircraft Systems in use today vary widely in a number of ways. Not only do they vary widely in size, but also in levels in autonomy and in the sophistication of the on-board mission computers. Some of the mission plans are extremely sophisticated and others are quite simple. Another variation is that some of the systems load the mission plan onto the mission computer before the aircraft takes off while other systems get the data for the mission through communication channels in real-time. In regards to maneuvering the unmanned aircraft some of the aircraft are controlled by a ‘stick’ method, and others are controlled purely by data through an autopilot. There are also differences in the qualifications to operate unmanned aircraft; only one military service requires the operator to be a trained pilot.

There is also a wide range of approaches for handling contingencies. Some unmanned aircraft attempt to handle a number of contingencies on-board, with the ability to override or handle them on the ground also. Others handle all contingencies from the ground. There are also many approaches that fall somewhere in between.

## **2.3 HALE UAS Flight Planning Considerations in the Future NAS**

The NAS is expected to change significantly over the next several years, with the introduction of new technologies and procedures. Planned and projected changes that may effect HALE UAS operations should be considered in the current effort to develop mission planning requirements. This section describes ongoing and future modifications to the NAS and how implementation could impact HALE UAS mission planning.

### **2.3.1 High Altitude Redesign**

The High Altitude Redesign (HAR) program's focus is to develop and implement fundamental changes in navigation structure and operating methods for en route operations for the high altitude airspace environment. Required Navigational Performance (RNP), Area Navigation (RNAV), and point-to-point navigation will incrementally replace the higher altitudes of the present jet-route structure at higher altitudes. The goal is to provide more freedom to properly equipped users and to achieve the economic benefits of flying user selected non-restrictive routings. Since initial HAR implementation will be at FL390 and above, and some features may be used at lower altitudes, HALE UAS operations will be impacted by the changes.

### **2.3.2 Domestic Reduced Vertical Separation Minima**

Domestic Reduced Vertical Separation Minima (DRVSM) will reduce vertical separation standards between flight level 290 to flight level 410 within the NAS, including Alaska and the Gulf of Mexico.

### **2.3.3 Privatization of the Automated Flight Service Station System**

Interactive briefings over the Internet, e-mail and PDA Notices to Airmen (NOTAM) alerts are expected changes to the flight planning process as Lockheed Martin takes over the Automated Flight Service Station system in October 2005. According to the FAA "Incremental consolidation of the 58 current flight service stations will begin in April 2006 and is expected to result in 20 sites by the end of March 2007." Additional internet functions and wireless technology will be introduced to improve service. During interactive online briefings, the FSS staffer and pilot will both be looking at the same charts and documents. If something changes while the flight is in the air, the briefer will be able to send an e-mail alert. If the changeover operates as promised phone calls will be answered by a live briefer within 20 seconds, radio call will be answered within 5 seconds, and the requested information will be supplied within 15 seconds. Urgent PIREPs are to be entered within 30 seconds into the system and routine report updated within 30 seconds. Flight plans are to take no more than 3 minutes to file.

### **2.3.4 Digital Communication in the Future for ATC**

It is expected that there will be VHF frequency spectrum saturation used for ATC voice within the next 10 to 20 years. There is an ongoing shift from cockpit voice radio to automatic digital communication via data link including digital voice communication. The automatic messaging reduces pilot workload and radio congestion while simplifying ATC procedures, and improving security. This changeover eliminates one of the hurdles with unmanned vehicle communication and ATC.

### **2.3.5 Proposed Operational Improvements to the NAS**

The FAA's Operational Evolution Plan (OEP) is a 10-year plan that details the operational improvements necessary to increase capacity and efficiency in the NAS. Operational improvements contain descriptions of specific system upgrades and new systems to be implemented in the NAS. Some of the systems that may impact flight/mission planning for unmanned aircraft are listed below.

## **3.0 HALE UAS UNIQUE PERFORMANCE AND OPERATIONS**

In order to identify flight/mission planning requirements that differ from those of current manned aircraft, it is necessary to identify the unique performance characteristics of HALE UAS currently flying, and from this, project the performance characteristics of those that will be produced in the near future. Additionally, potential HALE UAS mission scenarios need to be considered in order to highlight the unique operational parameters that may impact the flight/mission planning process.

### **3.1 Current HALE UAS Descriptions**

A HALE UAS, currently as defined in the Access 5 Concept of Operations, is capable of performing flights at an altitude of 40,000 feet mean sea level (MSL) or higher, for durations of at least 24 continuous hours (currently being revised to 43,000). The systems being considered for simulation and flight research by Access 5 include AeroVironment's Helios, General Atomics' Altair, Northrop Grumman's Global Hawk, and Aurora Flight Sciences Perseus B. Each one has characteristics that are significantly different from the others and a short synopsis of performance and operational capabilities of interest is provided below.

#### **3.1.1 Helios**

Helios is an ultra-lightweight flying wing aircraft with a wingspan of 247 feet, longer than the wingspan of the Boeing 747 commercial jetliner. The cruising speed of Helios ranges from 17 to 25 knots. The only flight control surfaces are 72 trailing-edge elevators that provide pitch control. To turn the aircraft in flight, yaw control is applied through these elevators. Helios is designed to operate at up to 100,000 feet, typical endurance mission is at 50,000 to 70,000 feet. When using solar power Helios is limited to daylight hours plus up to five hours of flight after dark on storage batteries. When equipped with a supplemental electrical energy system for nighttime flight, it can operate from several days to several months.

#### **3.1.2 Perseus B**

Perseus B is designed to operate in the 65,000-foot (20 kilometer) altitude region and has a duration goal of 96 hour. It has a wingspan of 61 feet and a maximum airspeed is 80 knots. Emergency recovery makes use of a termination chute.

#### **3.1.3 Altair**

ALTAIR was specifically designed as an unmanned platform for both scientific and commercial research missions. ALTAIR has an 86 ft wingspan, can fly up to 52,000 ft, and with a cruise speed of approximately 144 knots can remain airborne for over 30 hours.

#### **3.1.4 Global Hawk**

Global Hawk is similar in performance to modern day transport aircraft. It has a wingspan of 116 feet and length of 44 feet and a cruise speed of 350 knots. The maximum operating altitude is

65,000 feet MSL. Global Hawk is optimized for long range and endurance and is capable of providing 24 hours on-station at a 1,200-nautical-mile range from the departure airport.

### **3.2 Projected Performance Characteristics**

Because HALE UAS vehicles are designed to have no people on board, it can be assumed that there will be large variations in performance characteristics, due to mission specific tailoring. Already HALE UAS vehicles exhibit a wide range of performance characteristics, and these differences will continue to vary as the technologies to support a wider range of missions at higher altitudes and longer mission duration develops. Some of the current areas of technology development that may contribute to a broader range of performance characteristics are included below:

1. High Altitude Aerodynamics
2. Alternative Energy/Propulsion Technology
3. Advanced Structures and Materials
4. Sensor Technology
5. Automated Aerial Refueling

In general, it may be assumed that the performance envelope of HALE UAS will be much broader in all areas than the performance envelope of manned aircraft that currently fly above FL430. The envelope will most likely encompass performance similar to that of current day high altitude balloons to that of current day transport aircraft. Some specific areas that may generate mission/flight planning considerations that differ from manned aircraft are included below:

1. Size -- May run from very small due to advances in miniaturization to very large due to mission or power related surface area requirements.
2. Climb and turn performance -- Turn performance and descent capability may be extremely limited, especially at low altitudes due to optimized high altitude performance. Climb performance may vary from very slow to very fast due to wide variations in wing loading and thrust-to-weight ratios.
3. Speed -- May vary from near stationary enroute, and even stationary while conducting its mission, to high Mach number dash capability from one on-station location to another.
4. Maneuverability -- Can vary from the maneuverability similar to manned aircraft to such limited maneuverability that the Unmanned Aircraft (UA) is unable to navigate along standard departure and arrival routes.
5. Airfield Operations -- Can vary from operations similar to manned aircraft but without a pilot to an UA needing to be towed onto the active runway.

### **3.3 Projected HALE UAS Missions and Scenarios**

HALE UAS are being considered for application to many different missions and scenarios. They have the potential to provide long-term surveillance, communications relay, and other military and civilian capabilities at a relatively low cost, without the limitations imposed by human support requirements or by satellite orbits. As capability and reliability increases, mission applications which expand the operational envelope and potentially create new considerations for mission/flight planning will continue to be found. Some potential applications that may generate mission/flight planning considerations that differ from manned aircraft are included below.

### **3.3.1 Security Surveillance**

This mission may include the need to rapidly respond from one on-station location to another to cover emerging surveillance requirements that are not in the original flight plan and then return to the original location for follow on tasking. Coordination of these high priority departures to a previously unknown point, with little or no notice, may create new flight/mission planning considerations.

### **3.3.2 Surveying and Agricultural/Atmospheric Monitoring**

This mission may include the need to maintain specific paths over specific points on the ground potentially during specified time periods. Currently, for operations such as this a NOTAM is generated and the airspace is avoided by other aircraft. If these operations are to become routine, the current procedure of restricting this airspace may not be acceptable. Filing for this type of routing with current flight planning documents and procedures may not be possible.

### **3.3.3 Communications Relay**

This mission may include the need for a high reliability in maintaining a given position for long duration; potentially on the order of months or even years. This extended time of flight may generate new mission/flight planning considerations that will ensure the Air Traffic Provider maintains awareness of the HALE UAS and any changes to mission intent that may occur.



## **4.0 HALE UAS FLIGHT/MISSION PLANNING IN THE NAS**

To speed the acceptance of routine unmanned aircraft in the NAS they should utilize existing procedures and policies as much as possible. Due to their unique performance and mission conduct, there are some differences from manned aircraft that will require development/modifications of procedures to enable routine operation of HALE UAS in the NAS. Some of these differences will affect the mission/flight planning process and will require changes to the current process used for manned flights.

### **4.1 Flight Plan Documentation and Processing**

The purpose of a flight plan is to convey the pilot's intentions to ATC. The current standard Flight Plan Form (FAA Form 7233) may not be capable of adequately conveying the intended HALE UAS operation to ATC as is; certain fields are not applicable to unmanned aircraft and some fields need to be modified or added to convey information unique to unmanned flight.

Initially there appear to be two ways to approach this difference. One approach is to use Form 7233 for unmanned aircraft and put N/A on non-applicable fields, modify the available input options to some fields, and possibly add an addendum to this which would include specific HALE UAS unique information required by ATC. The other approach is for the FAA to define a unique form for unmanned aircraft.

#### **4.1.1 Current Flight Plan Considerations for HALE UAS**

A block by block discussion of considerations for using the current standard Flight Plan Form (FAA Form 7233) is contained below.

**Block 1.** Check the type flight plan.

A new category of flight plan may need to be developed for unmanned vehicles such as, EFR (Electronic Flight Rules). This type of flight plan will refer to electronic "see and avoid" or other equivalent safety approaches to collision avoidance.

**Block 2.** Enter complete aircraft identification including the prefix "N" if applicable.

The "N" prefix is the ICAO designation for U.S. aircraft. It is assumed that U.S. UA's will also use the "N" prefix.

**Block 3.** Enter the designator for the aircraft, followed by a slant(/), and the transponder or DME equipment code letter; e.g., C-182/U. Heavy aircraft, add prefix "H" to aircraft type; example: H/DC10/U. Consult an FSS briefer for any unknown elements.

This is one place changes will likely occur to identify HALE UA. Using a different prefix, such as R, may readily identify the aircraft as remotely operated. Also, new suffixes after the slant may allow ATC to know at a glance how the aircraft is equipped. The current suffix set, shown below, may not allow sufficient distinction of equipage levels for HALE UA.

**Block 4.** Enter your computed true airspeed (TAS). Currently, if the average TAS during flight changes plus or minus 5 percent or 10 knots, whichever is greater, the pilot is to advise ATC.

HALE UA may need to provide additional performance information since performance capabilities may vary over a wider spectrum than for manned aircraft. For example, it may be necessary to provide information on average climb rates or angles and average descent rates or angles if the aircraft is going to climb and descend through mixed airspace. This information could be coded into the flight plan using additional blocks, or a better solution may be to provide look up tables at each ATC control station based on the information provided in Block 3.

**Block 5.** Enter the departure airport identifier code (or the name if the identifier is unknown). Use of identifier codes will expedite the processing of your flight plan.

HALE UAS airfields may have a special designation or this may be a place that could be used to convey unique taxi and takeoff procedures.

**Block 6.** Enter the proposed departure time in Coordinated Universal Time (UTC) (Z). If airborne, specify the actual or proposed departure time as appropriate.

Note: It is doubtful that VFR departures will be allowed for HALE UAS.

**Block 7.** Enter the requested en route altitude or flight level. Only the initial requested altitude is entered in this block. When more than one IFR altitude or flight level is desired along the route of flight, it is standard practice to make a subsequent request direct to the controller.

It is assumed that Step 1 of ACCESS 5 will require predetermination of the altitude at which the HALE UA enters into mixed-use airspace. For reasons pointed out under Contingency Flight Planning, it may be necessary to file this altitude as the requested altitude and put it into the default flight plan rather than the final desired enroute altitude. That way if the vehicle suffers lost link during the departure/climb phase of flight the vehicle will automatically level out at an altitude below mixed use airspace and the controller will be expecting this level off.

**Block 8.** Define the route of flight by using NAVAID identifier codes (or names if the code is unknown), airways, jet routes, and waypoints (for RNAV). Use NAVAIDs or waypoints to define direct routes and radials/bearings to define other unpublished routes.

HALE-UA missions may require high-altitude loiter, holding patterns, or random routings off of the predefined jet route structure. The FAA is presently engaged in a redesign of high altitude airspace (above FL 390) to provide greater flexibility for Non-Restrictive Routings in much of the airspace. The key to this program is the establishment of the NRS (Navigation Reference System) which will allow properly equipped aircraft to file flight plan routes in terms of this grid structure that is pinned to line of latitude and longitude. This system will be very helpful in giving HALE UA the route flexibility needed to meet mission objectives. (See Advisory Circular 90-99). Additionally, some HALE UAS

missions may have complex routes that contain a much larger number of waypoints than that of current manned operations. In this case, conveying the intended route to ATC on the current form may not be possible.

**Block 9.** Enter the destination airport identifier code (or name if the identifier is unknown).

HALE UAS airfields may have a special designation.

**Block 10.** Enter your estimated time en route based on latest forecast winds.

Currently this block is specified in hours and minutes. For missions lasting days or even weeks this block may have to be expanded or redefined. Since lost communications procedures are based on this value, there are further considerations if communications are lost to an unmanned aircraft.

**Block 11.** Enter only those remarks pertinent to ATC or to the clarification of other flight plan information, such as the appropriate radiotelephony (call sign) associated with the designator filed in Block 2. Items of a personal nature are not accepted. Do not assume that remarks will be automatically transmitted to every controller. Specific ATC or en route requests should be made directly to the appropriate controller. Currently, this is where aircraft will specify that they are equipped to use and want to use the Navigation Reference System (NRS) for navigation.

Information unique to unmanned operations may be conveyed in this block. Consideration may be given to developing standard codes for specific information.

**Block 12.** Specify the fuel on board, computed from the departure point.

HALE UAS aircraft may use alternate forms of fuel such as solar and electric that has different considerations from aviation gasoline. Standard codes for different types of fuel might be added to this block

**Block 13.** Specify an alternate airport if desired or required, but do not include routing to the alternate airport.

HALE UAS may require a multiple number of alternate airfields due to mission duration and the potential for the potential to lose the ability to command the aircraft at various segments of the route.

**Block 14.** Enter the complete name, address, and telephone number of pilot-in-command, or in the case of a formation flight, the formation commander. Enter sufficient information to identify home base, airport, or operator. This information would be essential in the event of search and rescue operation.

For HALE UAS flights this would be the person ultimately responsible for the safety of the flight. Since the pilot is not onboard a HALE UAS this could be the remote pilot, a mission planner, a mission commander, or other designated individual.

**Block 15.** Enter the total number of persons on board including crew.

Some of the possible options for this block are to use “N/A”, a “0”, or just to leave it blank.

**Block 16.** Enter the predominant colors.

This block should be suitable as is for HALE UAS.

## **4.2 Weather**

A preflight weather briefing provides crucial information to assist in the planning of safe and efficient flights. This briefing includes information such as current and forecast weather for departure, enroute, and arrival, expected weather at an alternate airport and other airports that could be used as an alternate/emergency landing sites, and hazardous weather.

HALE UAS may have significantly expanded weather requirements compared to manned aircraft due to the following factors:

1. HALE UA may not be as capable of “all weather” operations as manned aircraft due to systems limitations, such as electrical power, redundancy, and bleed air sources.
2. HALE UA may have significantly more restrictive flight envelopes, especially in terms of speed and load factor, due to their designs being optimized for long endurance at very high altitudes.
3. HALE UAS will not be able to benefit from insitu weather assessment and weather avoidance to the same degree as manned aircraft.
4. HALE UA will operate for much longer mission durations than manned aircraft, which will mean making go/no-go weather decisions based on much less reliable and less detailed weather products.
5. Some HALE UA will operate in altitude bands where current weather products are limited. The National Weather Service, National Meteorological Center has no current requirements to produce weather products or forecasts above FL 550.
6. Due to the reliance of HALE UA on electronic links for command and control, weather effects on these electronic links will be important. Weather products to allow the measurement and forecasting of such effects are not presently mature.

An assessment of current weather product availability for flight planning needs to be made to determine if the content and method of providing weather information for the planning of HALE UAS operations is sufficient to conduct a safe flight. Requirements for weather related products and methods of disseminating will follow from this assessment. Initial areas for consideration are listed below.

While the need for routine weather information, both current and forecast, at altitudes above FL430 is not new, the availability of forecast weather data and products is limited for altitudes above FL430 and the National Weather Service (NWS) National Meteorological Center (NMC) has no current requirement to produce forecast weather data and products above FL550.

Hazardous weather will also have potentially significant impact on HALE UA operations. Due to their physical structure, HALE UA may not possess certain equipment to deal with various weather related hazards such as icing, or may be more susceptible to certain weather phenomenon such as clear air turbulence.

Due to the dynamic nature of weather, forecasts of weather that will effect HALE UA operations will not be available to cover the entire flight duration. There exists a need to consider the establishment of a requirement that will ensure the flight plan of the HALE UAS is updated, perhaps at a given interval, for changes in weather that were unknown prior to flight. The process needs to ensure that the flight plan changes are known to all parties. Details of specific weather requirements will be developed by the Access 5 Weather Work Package.

## **4.3 Communications**

For HALE UAS operations, communication is required between the pilot and the aircraft, the pilot and ATC, and ATC and the aircraft. Mission/flight planning should include a communications plan, but actual communication requirements are beyond the scope of this document and will be developed by the Access 5 Command, Control, and Communications Work Package.

### **4.3.1 General**

Mission/flight planning for communications should ensure that sufficient coverage, whether Line of Sight (LOS) or Beyond Line of Sight (BLOS), exists to maintain the communications link between the pilot and the aircraft, the pilot and ATC, and ATC and the aircraft; even if the aircraft has the capability to perform automatic route flying. In addition to the primary communication link there also needs to be a secondary communication link to be used as a backup if there are problems with the primary link.

All communications used for controlling the aircraft and possibly those for communication between the pilot and ATC must to be secure; this can be accomplished through the use of encryption keys and encrypted data links. Voice communication with ATC is generally not secure but can be secured using special radios if required.

### **4.3.2 Communications between the Pilot and the Aircraft**

Communication will probably include both terrestrial and extraterrestrial data links and may require additional capability of current data links to ensure safe integration with manned aircraft in the NAS. Additional bandwidth may be required in order to support more sophisticated weather reporting from the HALE UAS, uplinking and downlinking of information associated with collision avoidance, increased voice communications relay, and downlinking of large amounts of

mission data, over long periods. There will also be an increased need for backup data links to ensure positive control of the vehicle at all times while operating in the NAS.

For routine operations in the NAS, there may also be the requirement to continuously update the aircraft's current flight plan, and possibly, multiple contingency flight plans. HALE UA may have to be capable, at all times, of assuming autonomous control in the event of a lost link and that will mean that it will have to have default and contingency flight plans that are current with regard to weather, airspace allocations, expected performance, and intended flight path with associated times, altitudes, etc.

Other considerations for communications between the pilot and the aircraft that need to be accounted for during the mission/flight planning process are listed below.

1. Data links necessary to support air refueling, such as shifting control temporarily to tanker aircraft.
2. Communications links to support unplanned reassignment of the HALE UA to a different area of operations, which implies the updating of the communications plan to include normal and contingency operations in the new area, transition communications plans, and plans for return to the original ground station.
3. Communications plans for controlled destruction of the vehicle in the event of anomalous operation that may endanger other airspace users or property or persons on the ground.
4. Contingency communications plans to covers periods of natural electronic interference (such as solar flares or electrically active storms), intentional electronic interference (jamming), or loss of ground-based communications links due to power outages, antenna loss, etc.
5. To the extent that voice relay through the aircraft is chosen as the primary means for the pilot and ATC to communicate, this data link will also have to support two-way voice communications that are reliable and redundant.

The integration of HALE UA into the NAS will place significant burdens on the communications links between the pilot and aircraft, for safety and mission effectiveness reasons. Mission planning in this environment will necessarily require significant attention be paid to both nominal and contingency communications plans.

#### **4.3.3 Communications between the Pilot and Air Traffic Control**

The two-way communications requirement of FAR 91.135 for operations in Class A airspace means that a HALE UAS pilot will have to maintain continuous contact with FAA controllers in the various FAA sectors and facilities as the aircraft transits through the airspace.

Mission/flight planning will have to ensure that a complete communications plan exists, with multiple contingencies for lost communications. Mission/flight planning may require planning for both voice relay through the aircraft and direct communications between the pilot and ATC facilities via radio or landlines.

In the case of two-way communication between the pilot and ATC through the use of radios, a review should be conducted of the Instrument Approach Procedure (IAP) charts for the airports

that are likely to be used, which would include ATC communication frequencies. Planning should also establish that the databases, charts and other sources of communication frequencies are current and NOTAMs (D) have been checked for any changes.

Mission planning for communications should include identifying land-line or other alternate communications capabilities between the pilot and ATC and ensuring that the method used is communicated and understood between the pilot and ATC.

A future possibility for meeting the requirement of FAR 91.135 could be voice recognition/electronic voice technology that could permit direct communication between ATC and the aircraft. However, the reliability of these technologies when applied over voice radio frequencies with all of their attendant problems, such as interference and simultaneous broadcasting, may make this approach unacceptable for some time for safety-critical applications.

#### **4.3.4 Communications between Air Traffic Control and the Aircraft**

Depending upon the decisions on how to proceed with the other two links, the planning for this link in the communications triangle could vary from safety-critical to nonexistent.

### **4.4 Airfield Operations**

Airfield operations for unmanned aircraft need special consideration since ground operations can differ significantly from manned aircraft; currently, some taxi to the active runway while others need to be towed. Prior coordinated procedures need to be publicized to the other airport users when an unmanned aircraft does not use taxi procedures similar to manned aircraft. Mission/flight planning will also cover considerations in the areas of communication safety and security during all airfield operations.

The possibility exists that unmanned aircraft, due to the close proximity of aircraft while taxiing and the ever-present problem of runway incursions will not be allowed to mix in with manned aircraft while on the airport surface. Mission/flight planning will have to account for this and other limitations and constraints that may be imposed by airport authorities on unmanned airfield operations.

If mixed ground operations are allowed, procedures for ground controllers to provide safe progressive taxi instructions that will ensure separation from ground equipment, vehicles, obstructions and other aircraft will need to be considered. If necessary, a call to the airport manager could be made to determine details of required lateral separation and clearances from obstacles on the ground while on taxiways, or in parking areas. Additionally, some HALE UA may be equipped with on-board systems to avoid cooperative traffic on the ground and the procedures for usage of this equipment will have to be considered during mission/flight planning.

### **4.5 Airspace**

Unmanned aircraft may be required to file for and fly a standard instrument departure (SID) and a standard arrival routing (STAR). Strict adherence to this standard routing will enable ATC to ensure separation from other aircraft, terrain and obstacles. During mission/flight planning standard procedures that are not available to the aircraft, because of such items as maximum

ground speed or rate of altitude change limitations will have to be identified. There may be a requirement to develop standard arrival and departure procedures that are specific to each HALE UAS.

As with planning a route for manned operations, current airspace information needs to be considered to include, but not limited to, current congested areas of airspace, noise abatement procedures, NOTAMs, Airspace Alerts, Temporary Flight Restrictions (TFRs), Military Training Routes (MTRs), Restricted Airspace, and Special Use Airspace (SUA). When planning for HALE UA routes further airspace restrictions may be imposed in an effort to reduce the likelihood of a midair collision or other matters. Specific requirements will have to be identified and incorporated in to the mission/flight planning process.

In Step 1 of the ACCESS 5 program, it is assumed that the HALE UA will climb and descend through reserved or precoordinated airspace. The exact mechanization of this arrangement with ATC authorities will determine the mission planning requirements for airspace coordination. Currently, reserved airspace consists of areas that are “owned” by a using authority and areas that are “owned” by ATC. For example, restricted areas and warning areas are “owned” by using authorities and the using authority determines their availability. When such airspace is not being used by the using authority it can be “loaned” back to ATC for routine NAS operations. Other reserved airspace, such as altitude blocks and TFRs are “owned” by ATC authorities and these authorities determine their availability. There are other forms of airspace that are not reserved, but in which special risks exist due to the concentration of specialized aerial activities, such as parachuting, gliders or military activities.

## **4.6 Traffic Avoidance**

Mission/flight planning should be the starting point for conflict avoidance, but, actual conflict avoidance requirements are beyond the scope of this document and will be developed by the Access 5 Cooperative Conflict Avoidance (CCA) Work Package.

Mission/flight planning should include routing the aircraft through airspace that will provide the least chance for conflict with other traffic.

Collision avoidance maneuvers, whether executed autonomously by the aircraft or by an operator on the ground, must be communicated to ATC. Because of the wide range of maneuvering abilities, the avoidance maneuver will be aircraft specific. If the maneuver can be stored in the mission plan or in the mission computer and the aircraft can execute the avoidance maneuver when it detects the maneuver is necessary, it should be performed this way. In other systems where the operator needs to perform the maneuver, a planned avoidance maneuver procedure needs to be in place so that when the situation occurs the operator can quickly execute the maneuver.

## **4.7 Alternate/Emergency Airfield**

An alternate airfield and a route segment to that airfield need to be specified in the mission plan. This needs to be specified in case of a contingency which requires a change of landing airfield.



Routes should be planned to maximize the availability of alternate or emergency airfields. When practical, the aircraft should be capable of automatically flying or gliding to an enroute alternate or emergency airfield autonomously.

## **4.8 Control Element**

The Control Element includes the necessary resources to perform the following functions: Mission Planning, Launch and Recovery, Vehicle Control and Operations, Support and Training, and Maintenance and Logistics. Additionally, the necessary resources used within the control element may include hardware, software, and human personnel skilled in performing the above functions.

The mission plan is almost always in a digital format but it does not have to be. If the mission planning is performed on a computer, it may be on the same system as the vehicle control and operations but it doesn't need to be. Not only does the mission planning not have to be on the same system it also does not need to be co-located.

The ability to check current weather and forecasts should reside on either the same system where mission planning is performed or another co-located system.

The ability to check for current congested areas of airspace, noise abatement procedures, NOTAMs, Airspace Alerts, TFRs, MTRs, Restricted Airspace, and SUA should reside on either the same system where mission/flight planning is performed or on another co-located system since these items need to be checked when planning the route during mission/flight planning.

## **4.9 Contingency Planning**

Contingency planning for HALE UAS will be a much larger exercise than for manned aircraft. For manned aircraft there is no need to be concerned about the loss of the human control and judgment elements in coping with unplanned events. Also, there is usually no need to plan beyond the few hours that the mission will last. Contingency planning for manned aircraft generally consists of planning alternate airports in the departure and arrival areas, planning fuel reserves, checking emergency equipment during preflight, and ensuring that emergency checklists and required equipment is aboard the aircraft. While mission/flight planning should take into account the possibility of contingencies occurring, and mitigating their effect through planned procedures, the actual methods of contingency management and associated requirements are beyond the scope of this document and will be covered in the Access 5 Contingency Management Requirements document. The general contingency areas covered in this document are those that were provided by the team developing the contingency management requirements.

### **4.9.1 Lost Link**

In this section lost link refers to the communication link between the pilot and the aircraft that result in the pilot not being able to command the aircraft. During mission/flight planning a lost link contingency route needs to be created in the mission plan to a holding area near the landing airport which will be executed a predefined number of minutes after link is lost. This holding area needs to be specified as one of the contingencies in the mission plan and shall be set where it does not affect normal traffic patterns. The aircraft needs to stay in this holding area until communications are re-established.

#### **4.9.2 Lost Communications**

In this section lost communications refers to the communication link between the pilot and ATC. In the event of lost voice communications, telephones need to be used as the backup. The procedures, including telephone numbers, need to be determined and confirmed during mission/flight planning.

#### **4.9.3 Onboard System Failures**

Failures could be considered minor or major based on the system that fails. Possible system failures and action to be taken should be considered during mission/flight planning. Failures to be reported to ATC and their corrective action should be understood by ATC.

#### **4.9.4 Control Station Abnormalities**

There needs to be a back-up control station to be used in the event of a control station abnormality. It would be expected that the mission plan would contain a contingency route similar to lost link where in the event of a control station failure the vehicle would fly a preprogrammed maneuver or route for a predetermined time. If the control station communicates before that time the vehicle would continue on the original mission. The mission plan also needs to contain the plan for what to do if the predetermined time has expired and the control station still isn't communicating.

#### **4.9.5 Abnormal/Emergency Termination of Flight**

If an abnormal/emergency termination of flight occurs and the vehicle can land at the planned airfield that should be done. If that is not possible landing at another UAS airfield should be attempted. If that is not possible the landing should be attempted at a non-UAS airfield, and lastly if that does not work the UA should attempt a controlled and safe landing in an uninhabited area. As many of these contingency routes as possible should be included in the mission plan. In any case, these procedures need to be either pre-established with ATC or established with ATC in real time.

#### **4.9.6 Weather Issues**

Weather contingencies would generally be handled as they happen; the pilot would modify the route and send the changes to the aircraft or would maneuver the aircraft to avoid the area with the weather problems.

#### **4.9.7 Multiple Failures**

When multiple failures occur it depends on what the specific failures are as to what should be done. Just because there are multiple failure it does not mean the aircraft needs to abort the mission and land. As mentioned previously possible system failures and action to be taken should be considered during mission/flight planning. Failures to be reported to ATC and their corrective action should be understood by ATC.

## 5.0 SUMMARY OF PLANNING RECOMMENDATIONS

The current mission planning requirements for manned and unmanned aircraft were reviewed to identify the applicable HALE UAS mission planning requirements. The resulting applicable mission planning requirements were then analyzed with consideration to the unique performance and operational characteristics of HALE UAS. Using the following assumptions, a preliminary set of recommendations for HALE UAS mission planning have been developed for Step 1 of the ACCESS Project.

- Mission/Flight planning requirements only cover pre-flight planning activities.
  - Actual re-planning during flight or dynamic re-tasking is not covered in the mission/flight planning requirements.
  - Planning preprogrammed contingency routes and options is part of flight/mission planning.
- Some issues that are UAS specific, to include those listed below, will be coordinated with the FAA and other appropriate agencies prior to mission/flight planning.
  - Special ground operations and/or departure limitations and procedures
  - Collision avoidance maneuvers (if applicable) and procedures
  - Contingency management procedures during loss of C2 communications link
  - Flight termination procedures

This section summarizes and lists a preliminary set of recommendations for HALE UAS mission planning requirements. The nomenclature that is used for organizing the requirements is a prefixed “MPR” (Mission Planning Requirement) with hierarchical number sequence. For example, MPR-1 is a high-level requirement with low-level requirements MPR-1.1, MPR-1.2, etc.... If necessary, subsequent decomposition to lower level requirements will continue the hierarchical sequences, for example, MPR-1.1.1, MPR-1.1.2, etc....

### 5.1 HALE UAS Mission Planning Requirements

The following paragraphs present the preliminary set of recommended HALE UAS Mission Planning Requirements. The phrase “Mission Planning Resources” refers to any hardware, software, and human personnel within the Control Element that is used to perform the mission planning function

MPR-0 is the System Level requirement that is used to define the overarching expectation of the mission planning function. It is traceable to the ACCESS 5 Concept of Operations Rev 4 and the ACCESS 5 Functional Requirements Document (FRD) Rev 1.

**MPR-0** – The Mission Planning Resources shall provide the capability for a HALE UAS mission/flight to be planned such that flight objectives can be accomplished safely, securely, and efficiently with minimum impact on the ATC system and other airspace users.

The Mission Planning functional requirements that support accomplishment of the system level requirement are described below and have been grouped into four general categories: Coordination, Code of Ethics, Voice Communication, and C2 Communication Link.

### Coordination

**MPR-1** – The Mission Planning Resources shall provide the capability to plan, and coordinate with appropriate controlling/supporting agencies, any mission/flight specific requirements.

**MPR-1.1** – The Mission Planning Resources shall provide the capability to plan, and coordinate the airspace a HALE UA will require for a climb to, and descent from, FL430.

**MPR-1.2** – The Mission Planning Resources shall provide the capability to plan flight termination contingency routes/procedures and coordinate associated airspace requirements.

**MPR-1.3** – The Mission Planning Resources shall provide the capability to plan, coordinate, and communicate any ground operations that differ from manned aircraft of equivalent class and category with airport management and other airport users.

**MPR-1.4** – The Mission Planning Resources shall provide the capability to plan, and coordinate any required prioritization of mission objectives or unusual mission requirements.

### Code of Ethics

**MPR-2** – The Mission Planning Resources shall provide the capability for a mission/flight to be planned that complies with the UAS code of ethics (avoid human injury or loss of life, avoid loss of property, self-preservation, and mission completion) during all operations.

**MPR-2.1** – The Mission Planning Resources shall provide the capability to plan contingency management routes in order to abide by the UAS code of ethics

### Voice Communications

**MPR-3** – The Mission Planning Resources shall provide the capability for a mission/flight to be planned that meets voice communication availability requirements between the pilot and controlling agency.

**MPR-3.1** – The Mission Planning Resources shall have the capability to provide the pilot responsible for the UAS during flight a list of direct telephone/land line numbers for all center controllers that will interact with the Air Vehicle Control element.

**MPR-4** – The Mission Planning Resources shall provide the capability for a mission/flight to be planned that adheres to lost communications routings and procedures.

**MPR-4.1** – The Mission Planning Resources shall provide the capability to plan contingency management routes to be implemented in the event of communications loss

### C2 Communication Link

**MPR-5** – The Mission Planning Resources shall provide the capability for a mission/flight to be planned that meets command and control communication (C2) availability requirements throughout the planned flight.

**MPR-5.1** – The Mission Planning Resources shall provide the capability to plan all routings which transition from line-of-sight C2 link to over-the-horizon C2 link such that they do not result in a gap in coverage.

**MPR-5.2** – The Mission Planning Resources shall provide the capability to identify the impact of known/forecast weather related phenomenon on C2 availability when planning the flight.

## **5.2 HALE UAS Mission Planning Requirement Traceability**

MPR-0 is the System Level mission planning requirement that is traceable to the ACCESS 5 Concept of Operations Rev 4 and the ACCESS 5 Functional Requirements Document (FRD) Rev 1. Future revisions will include traceability to other applicable ACCESS 5 Work Package developed requirements documents, as well as, relevant regulatory documents external to ACCESS 5. Table 1 shows the traceability of Mission Planning Requirements presented above. Column 1 lists the Mission Planning Requirement and column 2 lists the traceability of the requirement. The following example expands the system level Mission Planning Requirement (MPR-0) to clarify the traceability reference. MPR-0 is traceable to paragraph 6.3.1 in the ACCESS 5 Concept of Operations (denoted with prefix C) Rev 4 and requirement number 2.3.2 in the ACCESS 5 Functional Requirements Document (denoted with prefixed F) Rev 1.

C-6.3.1 Mission Planning Operations: “The objective of mission planning is to develop a mission profile that meets the user requirements and, at the same time, tries to minimize the impact on the ATC system and other airspace users. HALE UAS operators will utilize the existing ATC infrastructure, so as to appear like any other user of the ATC system. Mission planning helps to ensure the proposed HALE UAS mission objectives can be accomplished safely and successfully in today’s regulatory and air traffic setting.”

F-2.3.2 Mission Planning: “The Control Element shall execute mission planning to ensure safe, secure, and efficient operation of the UAS within the NAS.”

Table 1 tabulates the traceability of each recommended Mission Planning Requirements.

**Table 1 - Mission Planning Requirements Traceability**

| Mission Planning Requirements | Traceability               |
|-------------------------------|----------------------------|
| MPR-0                         | C-6.3.1, F-2.3.2           |
| MPR-1                         | C-5.2                      |
| MPR-1.1                       | C-D.3.1                    |
| MPR-1.2                       | C-6.3.5.3, C-D.3.1         |
| MPR-1.3                       | C-6.3.2, F-2.1.4           |
| MPR-1.4                       | C-6.3.4                    |
| MPR-2                         | F-2.1.4, F-2.2.4.2         |
| MPR-2.1                       | F-2.1.5                    |
| MPR-3                         | C-6.3.4                    |
| MPR-3.1                       | F-2.4.11, F-3.3.4, F-3.3.6 |
| MPR-4                         | F-2.3.4.1                  |
| MPR-4.1                       | F-2.3.4.1                  |
| MPR-5                         | C-6.4                      |
| MPR-5.1                       | C-6.4                      |
| MPR-5.2                       | F-2.3.5                    |

## 6.0 ACRONYMS

|       |   |
|-------|---|
| ADIZ  | Air Defense Identification Zone               |
| AFSS  | Automated Flight Service Stations             |
| ATC   | Air Traffic Control                           |
| ARTCC | Air Route Traffic Control Center              |
| BLOS  | Beyond Line of Sight                          |
| C2    | Command and Control                           |
| CCA   | Cooperative Conflict Avoidance                |
| CFR   | Code of Federal Regulations                   |
| COA   | Certificate of Authorization                  |
| DOD   | Department of Defense                         |
| DRVSM | Domestic Reduced Vertical Separation Minima   |
| DUATS | Direct User Access Terminal System            |
| FAA   | Federal Aviation Administration               |
| FAR   | Federal Aviation Regulation                   |
| FL    | Flight Level                                  |
| FRC   | Full Route Clearance                          |
| FSS   | Flight Service Station                        |
| HALE  | High Altitude, Long Endurance                 |
| HAR   | High Altitude Redesign                        |
| IAP   | Instrument Approach Procedure                 |
| IFR   | Instrument Flight Rules                       |
| LOS   | Line of Sight                                 |
| MSL   | Mean Sea Level                                |
| MTR   | Military Training Route                       |
| NAS   | National Airspace System                      |
| NASA  | National Aeronautics and Space Administration |
| NMC   | National Meteorological Center                |
| NOTAM | Notice to Airmen                              |
| NWS   | National Weather Service                      |
| OEP   | Operational Evolution Plan                    |
| PAR   | Preferred Arrival Route                       |
| PDR   | Preferred Departure Route                     |
| RNAV  | Area Navigation                               |
| RNP   | Required Navigational Performance             |
| ROA   | Remotely Operated Aircraft                    |
| SID   | Standard Instrument Departure                 |
| STAR  | Standard Arrival Routing                      |
| SUAS  | Special Use Airspace                          |
| TFR   | Temporary Flight Restrictions                 |
| UA    | Unmanned Aircraft                             |
| UAS   | Unmanned Aircraft System                      |

## 7.0 DEFINITIONS

***Air Vehicle Control Station (AVCS)*** - A site configured to allow a pilot in command of an UAS to operate and monitor all UAS operations conducted under his or her authority.

***ATC Communication Link*** - Two-way data or voice link between the UAS system and Air Traffic Control and/or other aircraft.

***Autonomous operation*** – Operations that do not require direct pilot control.

***Certificate of Authorization (COA)*** - An FAA grant of approval for a specific operation(s).

***Command and Control Link*** – The two-way data link between the UA pilot and the UA used to control and monitor the health and status of the UA.

***Control Station*** – The equipment from which the HALE UA's pilot remotely controls and monitors the flight and mission activity of the UA.

***High Altitude, Long Endurance (HALE) UAS*** – A UA system capable of performing the mission objectives at an altitude of 43,000-foot mean sea level (MSL) or higher with sufficient cruise capability to transit the NAS.

***Manned Aircraft*** – Aircraft that are piloted by a human onboard.

***Mission Area*** – Airspace of defined horizontal and vertical dimensions and a defined duration within which the UAS may operate freely, and not associated with the flight route between the departure and arrival airport(s).

***Operator*** - The individual that monitors and controls an UA through near-real-time issuance of command and control input to the aircraft and possesses the applicable aeronautical knowledge but is not necessarily an FAA rated pilot.

***Over-the-Horizon*** – The condition where the control station and the UA are beyond line-of-site from each other.



## **8.0 BIBLIOGRAPHY**

1. FAA Order 7160.4K, “*Special Military Operations*”, Effective Date: February 19, 2004.
2. FAA Order 7110.10R, Change 2, “Flight Services”, Effective Date: February 17, 2005.

## **9.0 APPENDIX A: FAA ORDER 7610.4K, CHAPTER 12, SECTION 9**

# **FAA Order 7610.4K**

## **Special Military Operations**

Effective Date: February 19, 2004

Includes Change 1, effective August 5, 2004

### **Chapter 12. SPECIAL MILITARY FLIGHTS AND OPERATIONS**

#### **Section 9. REMOTELY OPERATED AIRCRAFT (ROA)**

#### **9.1 12-9-1. OPERATION**

a. ROA Operations should normally be conducted in the following areas:

1. Within Restricted Areas.
2. Within Warning Areas.

b. For those operations that cannot be contained wholly within Restricted Areas or Warning Areas, the ROA operations shall be conducted in accordance with procedures outlined in paragraph [12-9-2](#), Procedures.

#### **NOTE-**

*Procedures for nonjoint-use DOD airfield operations will be as specified by DOD.*

#### **9.2 12-9-2. PROCEDURES**

ROAs operating outside Restricted Areas and Warning Areas shall comply with the following:

a. At least 60 days prior to the proposed commencement of ROA operations, the proponent shall submit an application for a Certificate of Authorization (COA) to the Air Traffic Division of the appropriate FAA regional office. COA guidance can be found in FAA Handbook [7210.3](#), Facility Operation and Administration, Part 6, Chapter 18, Waivers, Authorizations, Exemptions, and Flight Restrictions. The following documentation should be included in the request:

**NOTE-**

*In the event of real-time, short notice, contingency operations, this lead time may be reduced to the absolute minimum necessary to safely accomplish the mission.*

1. Detailed description of the intended flight operation including the classification of the airspace to be utilized.
2. ROA physical characteristics.
3. Flight performance characteristics.
4. Method of pilotage and proposed method to avoid other traffic.

**NOTE-**

*Approvals for ROA operations should require the proponent to provide the ROA with a method that provides an equivalent level of safety, comparable to see-and-avoid requirements for manned aircraft. Methods to consider include, but are not limited to; radar observation, forward or side looking cameras, electronic detection systems, visual observation from one or more ground sites, monitored by patrol or chase aircraft, or a combination thereof.*

5. Coordination procedures.
6. Communications procedures.
7. Route and altitude procedures.
8. Lost link/mission abort procedures.
9. A statement from the DOD proponent that the ROA is airworthy.

**NOTE-**

*The proponent should ensure that the ROA contains a means to safely terminate the flight, follow specified and defined procedures for mission abort, or proceed in accordance with specific flight termination procedures.*

- b. COAs shall have an effective date with a duration not to exceed 1 year unless renewed or revalidated. The COA expires on the stated termination date, unless sooner surrendered by the proponent, or revoked by the issuing agency.
- c. ROAs shall be equipped with standard aircraft anti-collision lights in accordance with criteria stipulated in 14 CFR Section 23.1401. These lights shall be operated during all phases of flight in order to enhance flight safety.
- d. ROAs shall be equipped with an altitude encoding transponder that meets the specifications of 14 CFR Section 91.215. The transponder shall be set to operate on a code assigned by air traffic control. Unless the use of a specific,

special-use code is authorized, the ROA pilot-in-command shall have the capability to reset the transponder code while the ROA is airborne. If the transponder becomes inoperative, at the discretion of the affected region or air traffic facility, the mission may be canceled and/or recalled.

e. Instantaneous two-way radio communication with all affected ATC facilities is required. For limited range, short duration flights, proponents may request relief from radio requirements provided a suitable means of alternate communication is available. Compliance with all ATC clearances is mandatory.

f. The proponent and/or its representatives shall be noted as responsible at all times for collision avoidance maneuvers with nonparticipating aircraft and the safety of persons or property on the surface.

## **10.0 APPENDIX B: FUNCTIONAL REQUIREMENTS FOR A HALE ROA MISSION PLANNING SYSTEM**

The functional requirements for a HALE UAS mission planning system should be derived from the mission planning requirements document. These functional requirements shall be used to define the minimum functionality that a HALE UAS mission planning system should contain to allow a HALE UAS operator to file an IFR flight plan and fly in the same day, without prior ATC coordination. This section will be included with the final version of the document.